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EXPERIENCES WITH AND IMPROVEMENTS OF THE TUBE VOLTMETER FOR THE LOSS-FREE MEASUREMENT OF HIGHER VOLTAGES

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Translation of "Erfahrungen und Verbesserungen am Röhrenvoltmeter zur verlustfreien Messung höherer Spannungen."
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EXPERIENCES WITH AND IMPROVEMENTS OF THE TUBE VOLT-METER FOR THE LOSS-FREE MEASUREMENT OF HIGHER VOLTAGES.

By Louis Weisglass, Certified Engineer, Vienna

Summary: It will be shown which properties of tubes are well suited to the tube volt-meter, and also, which methods are to be used to modify the measuring range within wide limits, in a convenient and simple manner.

The various advantages and the good usability of this tube volt-meter, which was described in the ETZ of 1927, p. 107, cause me to report new experiences gathered by its use. This work was carried out in the Laboratory of the Viennese physicist, Engineer Siegmund Strauss, and under his direction. The development of the tube volt-meter resulted from purely practical motives, since its use was indispensable for certain measurements. In this work, it was particularly a matter of following the internal physical processes on the X-ray dosimeter "Mekapion" as precisely and as thoroughly as possible, and especially of using such a method that the many hundred measurements, that will turn out to be necessary, will not have a tiring effect. In this dosimeter[1)], a small condenser having a capacity of 30 to 40 cm, is charged with a few electrostatic units and is then left to itself. The discharge process is effected by an ionic current of the order of magnitude of 10^{-12} Ampere, that originates in the X-rays. The current will never fall below a certain low potential, on the condenser. At that point, an automatic re-charging process will take place.

It was necessary to follow these processes carefully by means of tests. Only the exact knowledge of the voltage curve will supply a guaranty in regard to the saturation of the ionization chamber during the entire

1) Cf. S. Strauss, Electrizitaet und Maschinenbau, v. 44, p.348

discharging process; it is this requirement that makes possible the proportionality between the radiation intensity and the indications of the instrument. As is well known, the measuring method consists in the decreasing of a grid current, that has been generated by a positive voltage, by means of the application of a negative anode voltage. The negative anode current is the testing current itself. An anode current as such can never come into existence. A possible consumption of current can come about only by a possible defective insulation of the gas. For that reason, e.g., amplifier tubes with the usual radio socket equipment cannot be used, largely due to the extreme closeness of the feed lines, in the press of the tube. In this volt-meter, the anode pole will have to have an outstandingly good insulation from the cathode. For that reason, it is advisable to use only tubes that possess a separate outward-lead of the anode. The marconi-D.E.V. tube may be used reasonably well. In Fig. 1, another tube has been shown, that has been designed especially for this purpose. On the top and on the bottom, it has normal presses; but solely the anode duct in the upper ones was used there. We wish to call attention here to a dangerous part of the insulation. That is the well-known magnesium mirror on the inner glass wall. This mirror must not, under any circumstances be too strong and form a closed cathode-anode circuit. Protective ring circuits and similar circuits were tested for an apparent boost of the insulation, and the results were highly satisfactory.

An important problem in the case of all measuring devices is the simple change of the measuring ranges. In the case of this tube volt-meter, an increase of the grid voltage generally is already accompanied by a strong increase of the grid current. But the grid, with its small surface, tolerates but poorly the temperature caused by the high cathode current; thereby, the risk of gas leakage is being increased. The following method has led

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to our goal in this respect, even though it imposes special limits on the measuring range. The heating system of the tube is set so low that full saturation will already exist in the case of small grid voltages that will still have to be selected. This saturation cathode current should be small; it should amount to, perhaps, 1 mA or even less. When we call the grid voltage that occurs in the case of saturation, the grid-saturation voltage, E_{gs}, and when we call the considerably higher grid voltage as adjusted later when the measuring range is increased, E_{gm}, then an interval $E_{gm}-E_{gs}$ will result that will not contribute any longer to the increase of the grid current (Fig. 2). The compensation of this grid voltage interval by the negative anode measuring voltage does not yet bring about, by itself, any reduction of the grid current. Only anode voltages that - when reduced on the grid - are larger than $E_{gm}-E_{gs}$ may be demonstrated by means of the retrogression of the grid current deflection. Accordingly, in this method, the upper as well as the lower point of the measuring range is being raised. This may be expressed in the following way:

Lower measuring value $E_{xu}=\frac{E_{gm}-E_{gs}}{D}$ (D = grid penetration factor)

Upper measuring value $E_{xo}=\frac{E_{gs}}{D}$,

Measuring range $E_{xo}-E_{xu}=\frac{E_{gm}}{D}$.

By this method, it is now simple to attain considerably high measuring voltages - as high as the tube is able still to tolerate well. In Fig. 3, a calibration curve for super-elevated grid tension has been presented.

We wish here to call attention also to a second method that can be used successfully. The measuring range is being increased by counter-connecting a certain voltage that has been taken from any voltage source, with the measuring voltage and by lowering, in that way, the measuring voltage that is lying on the anode. Consequently, this voltage will be equal to the voltage read as augmented by the additional voltage (Fig. 4). It

should also be mentioned that only tubes with the very best vacuum should be used. In the case of tubes containing any gas, an ionic current is being formed - since there always flows a stream of electrons - which will cause the condenser charges to flow off more rapidly. Thoriated tubes may well be used; their emission will be constant throughout since no exaggerated demands are being made upon them. Since the tubes are underheated, due to the very small grid currents, and since they are not charged, their lives are rather long, and the calibration curve that has been drawn once, retains its calibration values for a long time. Of course, the heating sensitivity is not insignificant in the case of this very setting; for that reason, particular attention will have to be paid to the good execution of the filament resistance.

The tube volt-meter as described has demonstrated by its constant use in the above-mentioned laboratory that is active in the field of measuring technology, that it is highly dependable and that it leaves nothing to be desired, inasmuch as simplicity is concerned. For these reasons, it can be used to good advantage not only in the laboratory, but also at other occasions.

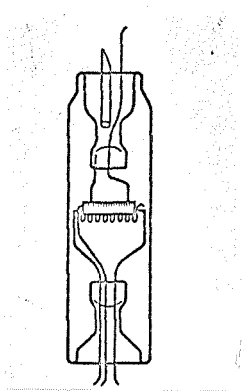

Fig. 1. Tube with insulated anode for tube volt-meter (Anode half open)

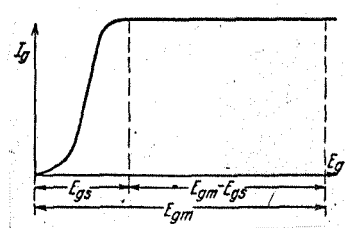

Fig. 2

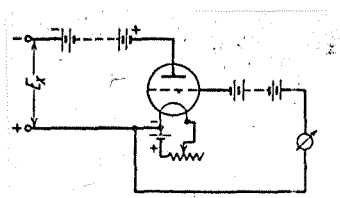

Fig. 4

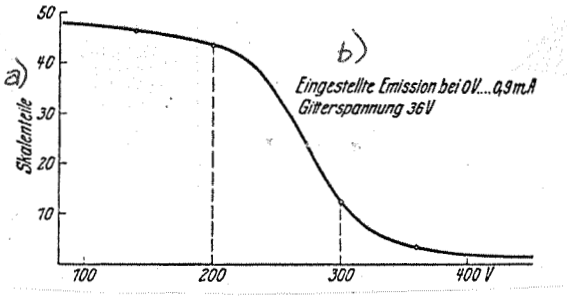

Fig. 3. Calibrated curve of the tube volt-meter with super-elevated grid tension. a) Parts of the scale, b) Adjusted emission at OV....0.9mA; Grid voltage = 36 V.